10/501382

DT15 Rec'd PCT/PTO 15 JUL 2004

Container

This invention relates to a container according to ISO standards, designed as a mobile work space for civilian and military use (shelter) according to the preamble of Patent Claim 1.

ISO containers with a cuboid metal structural frame comprising ISO corners and edge profiles connecting these ISO corners, as well as thermally insulated side walls, ceiling and floor are known from German Patent **DE 37 19 301 C2**, for example.

The construction of the structure for CSC-certified stackable containers (1:1 design, not expandable, e.g., German Patent **DE 37 19 301 C2**, and 1:2 and 1:3 expandable designs, e.g., European Patent **EP 0 682 156 B1**) is obtained essentially from the stresses that occur in shipping and the vertical loads that occur when up to nine units are stacked (CSC: International Convention for Safe Containers). Point loads and area loads are specified for the container bottom. The tare weight of the equipment to be mounted there must be applied to the walls. Wall cutouts for doors (emergency exit) and for the power supply, air conditioning ducts and optionally the water supply increase the structural complexity and the number of heat bridges.

The thermal insulation should not be at the expense of the interior size and/or increasing the empty weight of the container. Heat transfer coefficients of 0.55 to 0.75 W/(m^{2}K) can be achieved easily with sandwich walls having shearing rigidity (sheet metal-polyurethane-sheet metal) with thicknesses of 40 mm to 60 mm. With current designs, the openings, edges and corners increase the k value of the entire container to values substantially greater than 1 W/(m^{2}K).

For civilian and military applications (mobile sanitation facilities and work rooms such as field command posts and communications systems) for use throughout the world, even under extreme climate conditions, there is a need for reducing the technical complexity and economic cost required for the power supply and [heating and] air conditioning. Transmission losses of the container, which is closed on all sides, may constitute 30% or more of the

heating and cooling demand, except for applications with an extremely high fresh air demand (operating rooms).

The problem of substantially improving the thermal insulation cannot be solved by thicker thermal insulation layers and not with the usual structural designs.

German Patent **DE 197 47 181 A1** discloses a refrigerated container or insulated container which includes thermally insulated side walls plus ceiling and floor, each framed by bordering copings. The bordering copings are designed as hollow profiles and have a core of thermal insulation material. By means of edge profiles designed in two parts, the side walls, ceiling and floor are fixedly joined together in the area of the bordering copings. One disadvantage of this container is the fact that heat bridges created due to the use of the hollow profiles have a negative effect on the heat transfer coefficient value of the container.

European Patent **EP 0 064712 A1** describes a refrigerated container having a continuous insulation layer. The exterior side of the insulation is formed by a steel frame with upper and lower cross beams and exterior wall panels. Interior planking is provided on the inside of the refrigerated container.

There is thus the object of reducing the heat transfer coefficient of the entire container without any sacrifice in terms of structural rigidity and interior size.

This object is achieved with the object of Patent Claim 1. Advantageous embodiments of this invention are the object of subclaims.

The object formulated here is achieved according to this invention by two approaches that are linked together:

X Reducing the transmission component of undisturbed areas by using vacuum insulation material which has a much lower thermal conductivity than polyurethane or mineral wool, for example, to compensate for the disadvantage of heat bridges, and

X A two-part design of all edge profiles of the container (in the form

of two partial profiles running in parallel and thermally separated from one another by thermal insulation material) for all horizontal and perpendicular edges of the cuboid ISO container. The intermediate space between the two partial profiles is filled completely by a thermal insulation material. This principle can also be applied similarly for all frames of area openings such as doors and drop doors. The structure of the container can thus be implemented largely without heat bridges.

The heat transfer coefficient of the container according to this invention can be brought into the range of 0.5 $W/(m^2K)$ by means of the measures described here without having to accept sacrifices in terms of structural rigidity or interior size. In particular, the inventive container can be stacked several units high without restriction.

The definite reduction in the heat transfer coefficient to values around 0.5 $W/(m^2K)$ in the case of a wall thickness comparable to that of conventional thermally insulated containers reduces the required capacity of the air conditioning system by the amount that results from the temperature difference between the interior and the environment and the greater temperature difference (plus and minus) between the air-conditioned air circulating in the side wall ducts and ceiling ducts. Heating of the container by means of radiant wall heat and/or floor heating becomes much more economical.

The inventive principle may be used for containers that are not expandable (1:1 design) as well as for expandable containers (1:2 design, 1:3 design, e.g., using pull-out elements).

The inventive container is in compliance with the strength and rigidity values stipulated by ISO standards. It is suitable in particular for stacking (up to nine containers stacked one above the other) and it withstands the stresses that occur (e.g., load due to crane vehicle) in shipping of the container, in which case the force is applied at the ISO corners.

The vacuum insulation technology developed for terrestrial applications is known per se and is used in the present invention (e.g., German Utility Model **DE 296 08 385 U1**); this means a reduction in the weight and volume of the insulation material and thus an increase in the useful volume at a

predetermined heat transfer coefficient. A granular or fibrous filler material together with a getter material, if necessary, and IR opacifiers is surrounded by a multilayer laminated film (metal foil and polyethylene film). With a system pressure of less than 5 mbar, tight welding of the films and a negligible permeation rate, a lifetime of more than 15 years is achieved at a thermal conductivity of approximately 0.004 W/(mK) according to the manufacturer's information. The size of the vacuum insulation sheets in the thickness range from 10 mm to 30 mm can be adapted to the geometric requirements.

The vacuum insulation, which is sensitive to damage, is advantageously protected toward the outside by the outer steel plate wall of the container and is preferably protected toward the inside by plastic-laminated plywood boards, the thickness of which is dimensioned for appropriate mounting of furnishings and/or to accommodate floor loads according to the use case of the container.

In an advantageous embodiment, in addition to an insulation layer of a vacuum insulation material, an additional insulation layer of traditional insulation materials (mineral wool, rock wool, Styropor, Styrodur, polyurethane, etc.), i.e., non-vacuum insulation materials, may also be provided toward the interior.

The edge profiles which run vertically and horizontally between two ISO corners can absorb normal forces and bending forces and may advantageously be designed as two partial L-shaped profiles merged together but also as two quarter circle profiles on the inside and outside or as an expander quarter round profile and a partial profile on the inside comprising a quadrilateral profile or a tube profile.

The outer sheet metal wall of a container surface, which contributes toward its shear strength, is advantageously welded to the outer partial profile of an edge profile and the ISO corners.

The large-area interspaces between opposing edge profiles are covered with vacuum insulation sheets, small intermediate spaces are filled with foam or with other conventional insulation materials tailored exactly to fit.

The intermediate spaces between two partial profiles of an edge profile

may also be filled with foam or with conventional insulation materials accurately tailored to fit. The recent development of a weldable steel plate-polyurethane sandwich may be of interest here both economically and from the standpoint of manufacturing technology.

With the small thickness of the walls and ceilings and the minor recoil of the wall surfaces at the ISO corners, they protrude into the interior of the container. To reduce these heat bridges, these protrusions must be covered with a layer of thermal insulation material in the form of a trunk corner. Especially here but also on all thermally critical locations, the thermal insulation is such that the dew point can never be reached anywhere on the inside surface.

One wall (side wall, ceiling or floor) of the container advantageously comprises the following layers from the inside to the outside:

! outer metallic cover layer,

! vacuum insulation layer,

! additional insulation layer of a non-vacuum insulation material,

! plywood layer,

! inner metallic or plastic cover layer.

To reinforce the side wall, ceiling or floor, reinforcing profiles may advantageously also be provided, these profiles being in contact either with the inner or outer metallic cover layer of a side wall, a ceiling or floor and separated from the other cover layer by a thermal insulation intermediate layer. Since the reinforcing profiles form essentially unwanted heat bridges, a metallic material with a low thermal conduction and a high strength may advantageously be selected for them.

To accommodate floor loads in spots and over the area, a compromise must be made for thermal reasons between thermal conduction, the cross profile of the profile and the distance between the reinforcing profiles (grid dimension). In addition to the choice of the smallest possible web thickness of the standard profiles, it may also be expedient to use composite welded profiles, with stainless steel plate being advantageous thermally for the web(s), either straight or inclined, because of the lower heat transfer coefficient.

With reference to the drawings, exemplary embodiments of this invention are described below.

FIG 1 shows the wall design of the inventive container with an L-shaped reinforcing profile;

FIG 2 shows the wall design of the inventive container with an assembled reinforcing profile;

FIG 3 shows a cross section through an inventive container in the area of an edge profile, where the edge profile consists of two L-shaped partial profiles;

FIG 4 shows a cross section through an inventive container where the edge profile includes a curved partial profile on the outside and a partial profile of a pipe profile with webs welded onto it on the inside;

FIG 5 shows a cross section through an inventive container with an edge profile consisting of two L-shaped partial profiles;

FIG 6 shows a cross section through a container in the area of a wall passage for a door or a drop door.

FIG 1 shows the wall structure (side walls, floor or ceiling) of an inventive container. Beginning from the outside, the multilayer wall structure includes the metallic outside wall 1 (steel plate planar or trapezoidal), a layer of vacuum insulation sheets 2 cut to size and inserted and having a thickness which depends on the requirement[s] regarding the quality of the heat transfer, the intermediate layer 3 of conventional insulation materials, e.g., mineral wool, a plywood 4 with a high E modulus to reinforce the wall for secure fastening of the interior furnishings of the container and finally the aluminum cover layer 5 which is to be glued onto the wooden board before assembly.

The total wall thickness is obtained from the wall stiffness requirements which are to be met with the lowest possible web thickness of the reinforcing profile 6 and the greatest possible web length (for definition of a web of a reinforcing profile, see FIG 2). Between the L-shaped reinforcing profile 6 and the plywood board 4 a strip 7 of thermal

insulation material is inserted. In the present case the reinforcing profile 6 is welded to the metal exterior wall 1 and the wooden boards 4 are attached by a rivet joint 8.

A variant of the reinforcing profile 6 consists according to FIG 2 of selecting stainless steel as the material for the web 6′ (i.e., the region of the profile 6 which runs across the layer structure and thus in the direction of heat conduction) for reasons of lower heat conduction and to weld it to the belt 6″ while otherwise having the same structure. In FIG 2 the reinforcing profile is designed in a T shape.

The path of the heat conduction may also be extended by placing the web 6′ at an inclination. A symmetrical arrangement of two webs 6′ per profile is expedient (symmetrical to a plane of symmetry perpendicular to the wall of the container), so that the webs 6′, belt 6″ and exterior wall 1 form a trapezoid. The resulting hollow space can be filled out with foam.

FIG 3 shows a vertical cross section through a container, with part of a side wall and the bottom being shown here. The side wall and bottom have the sequence of layers according to FIG 1 or FIG 2: exterior cover metal plate 1, vacuum insulation layer 2, insulation layer of traditional insulation material 3, plywood board 4, 4″, interior metal cover layer 5. It can be seen here that within the bottom, the plywood layer 4′ is slightly thicker than in the case of the corresponding plywood layer 4 in the side wall and the roof (not shown in FIG 3). The edge profile of the container is formed from two L-shaped partial profiles 10 and 11 placed one inside the other, welded together at their end faces with ISO corners (one ISO corner 13 is visible in this sectional drawing). The outer cover plates 1 are welded at points 1′ and 1″ to the profile legs of the outer partial profile 10. The intermediate space between the interior and exterior profiles 10, 11 is filled with insulation material 40, inserted after the welding operation or foamed in place. The entire intermediate space between the profiles 10, 11 is thus filled homogeneously by the insulation material 40 so there are no heat bridges. In particular there are no other beam profiles (in contrast with the abovementioned German Patent **DE 197 47 181 A1**, for example) between the two partial profiles 10, 11. Preferably a non-vacuum insulation material is used

as the insulation material. The cover angle 14 preferably made of plastic covers the seam between the floor and the side wall.

If a greater rigidity is necessary for the horizontal container edges around the bottom, then according to FIG 4 the interior partial profile may have a greater cross section, e.g., may be designed as a pipe 20 with tabs 21 and 22 welded on for fastening the interior covers 4 and 5 and/or 4' and 5.

The exterior partial profile of the two-part edge profile is designed as an arc of a circle 23 in this embodiment.

FIG 5 shows a horizontal cross section through a container in the area of a vertical container wall. The two abutting side walls designed according to FIG 1 and FIG 2 can be seen here. The two-part edge profile again consists of the two L-shaped partial profiles 10, 11 whose end faces are welded to a surface of the ISO corner 31. If the leg lengths of conventional L profiles cannot be coordinated with their distance so that there is no offset in the joints 25, 26 in relation to the walls 27, 28, this does not constitute in principle a structural change in the wall design.

The three-layer lining 30, e.g., a foamed surface compacted plastic, covers the areas of the ISO corners 31 protruding into the interior of the container to diminish the effect of the heat bridge formed by the ISO corner.

FIG 6 shows an exemplary embodiment of a wall opening for a door or drop door. The layer structure of the wall 40 and door or drop door 41 is identical. The layer structure depicted here has only an insulation layer consisting of a vacuum insulation material in contrast with the embodiments depicted in the previous figures.

The opening is bordered on the side of the drop door as well as on the wall side by ceiling panels 42, 43 and/or 44, 45 in two parts. The intermediate thermal insulation layers 46, 47 between the ceiling panels 42, 43 and/or 44, 45 prevent the transfer of heat. The element 48 provides the seal around the frame. The hinges 49 are mounted on the outside of the container.